Assignment NO: 01

Name :- Pratik . V. Tabhane.

Roll. no :- 116076

PRN :- 1032221030

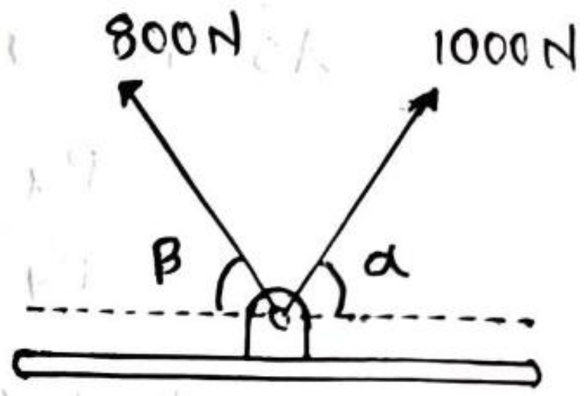
Div :- 16

Subject :- Engineering mechanics

* Solve the following questions :

·Question no :- 01

Forces are transmitted by Two members as shown in fig. If the resultant of these forces is 1400 N directed vertically upward, find angles α and β



·Solution :

As two angles are unknown, the parallelogram law will be convenient to use. Let P = 1000 N, Q = 800 N Their resultant is R = 1400 N as shown in fig.

(a) The angle between P and Q is α' and angle made by R with P is θ as shown in fig.

$$R^2 = P^2 + Q^2 + 2PQ\cos\alpha'$$

$$1400^2 = 1000^2 + 800^2 + 2(1000)(800)\cos\alpha'$$

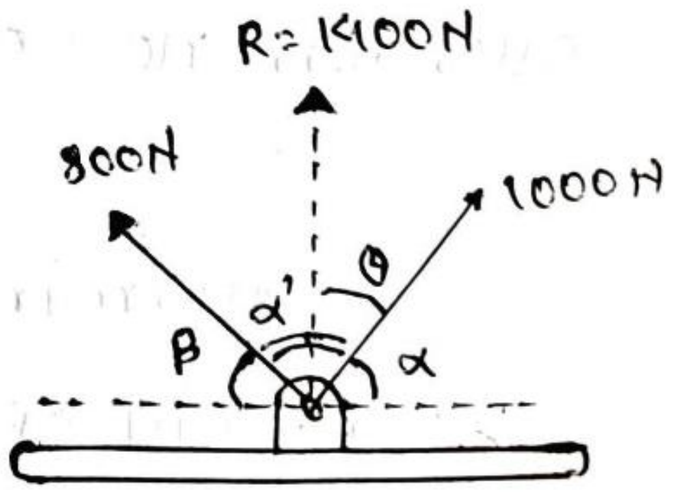
$$\alpha' = 78.46^\circ$$

$$\tan\theta = \frac{Q\sin\alpha'}{P + Q\cos\alpha'}$$

$$\tan\theta = \frac{800\sin 78.46}{1000 + 800\cos 78.46}$$

$$\theta = 34.05^\circ$$

$$\alpha = 55.95^\circ$$



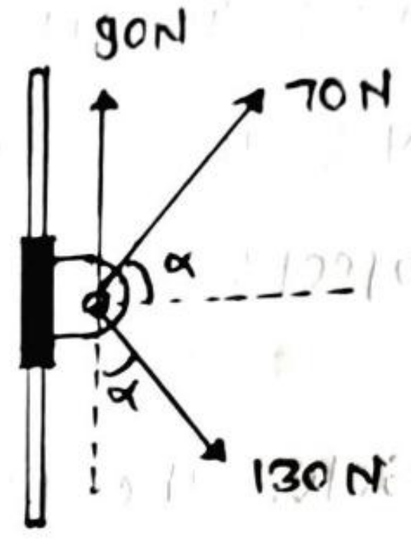
$$\beta = 180 - \alpha - \alpha' = 180 - 55.95 - 78.46$$

$$\beta = 45.59^\circ$$

$$\alpha = 55.95 \text{ , } \beta = 45.59^\circ$$

Question. no : 02

A collar that can slide on a vertical rod is subjected to the three forces shown.
Determine: (a) the value of the angle α for which the resultant of the three forces is horizontal,
(b) the corresponding magnitude of the resultant.



Solution:

As the resultant is horizontal,

$R_x = R$ and $R_y = 0$

$R_y = 0 \implies \Sigma F_y = 0$

$\therefore \quad 90 + 70\sin\alpha - 130\cos\alpha = 0$

$$\boxed{\alpha = 24.14^\circ}$$

$R_x = R \Rightarrow \Sigma F_x = R$

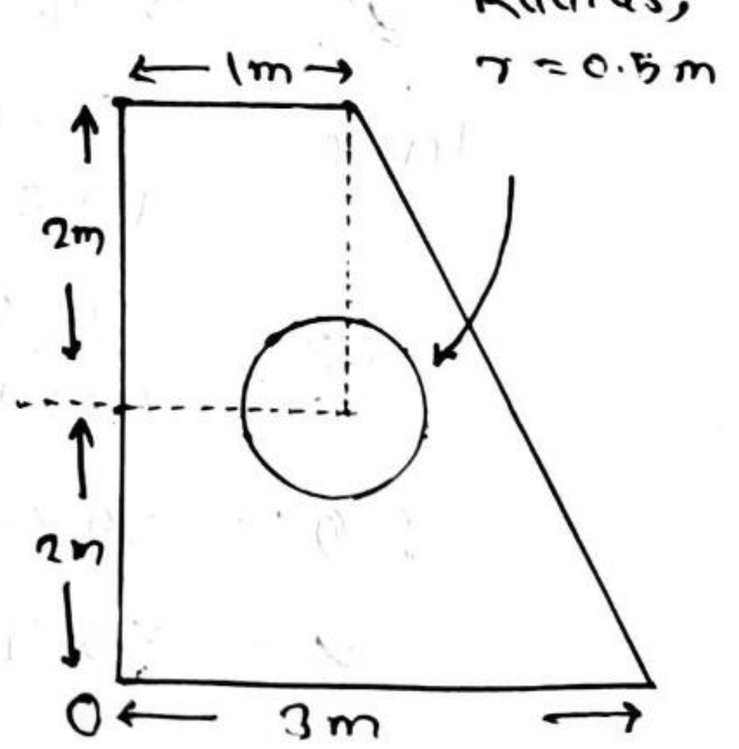
$70\cos\alpha + 130\sin\alpha = R.$

$R = 70\cos 24.14 + 130\sin 24.14.$

$$\boxed{R = 117.04\ N}$$

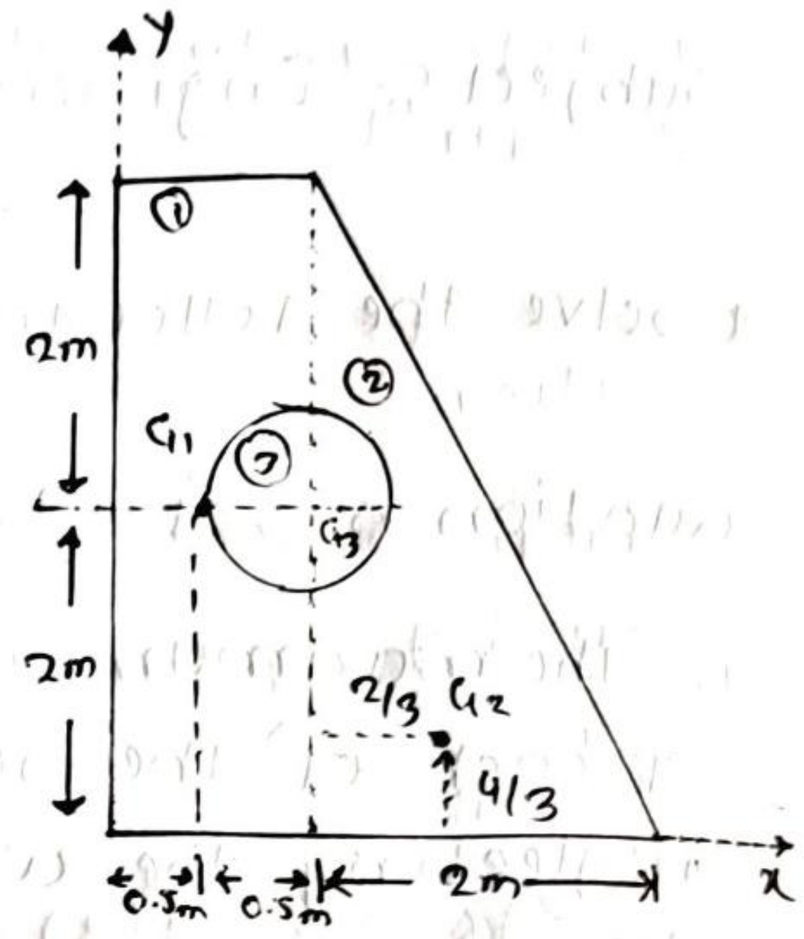
Question no : 03

Determine the position of centroid of the shaded area as shown in fig. with respect to origin O.



Solution:

Divide the area into a rectangle, triangle and a circle as shown in fig.



calculations are tabulated as follows:

comp. NO.	$A(m)^2$	x(m)	y(m)
1	1×4	0.5	2
2	$\frac{1}{2} \times 2 \times 4$	$1 + 2/3$	$4/3$
3	$-\pi \times 0.5^2$	1	2

$\sum A = 7.2146\ m^2$

$\sum A_x = 7.88\ m^3$;

$\sum Ay = 11.76\ m^3$

$\bar{x} = \frac{\sum Ax}{\sum A} = \frac{7.88}{7.2146}$

$\boxed{\bar{x} = 1.092\ m}$

$\bar{y} = \frac{\sum Ay}{\sum A}$

$= \frac{11.76}{7.2146}$

$= 1.63\ m$

$\boxed{\bar{y} = 1.63\ m}$

Assignment NO : 02

Name :- Pratik . v . Tabhane

Roll . No : 116076

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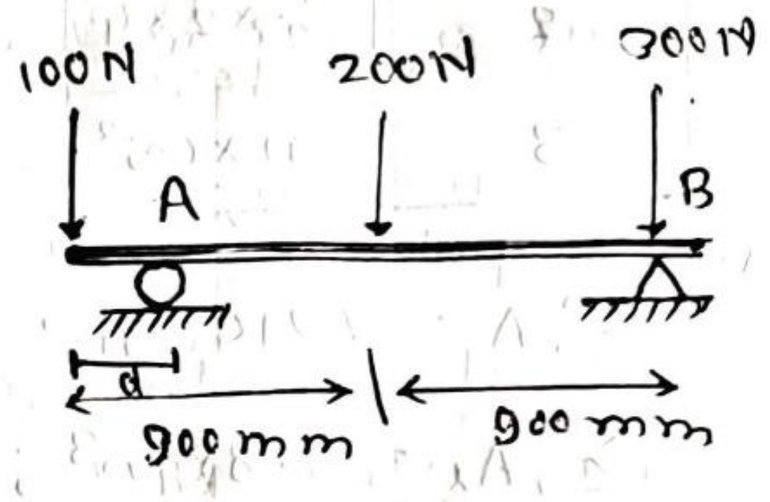
Div :- 16

Subject :- Engineering Mechanics .

* Solve the following questions:

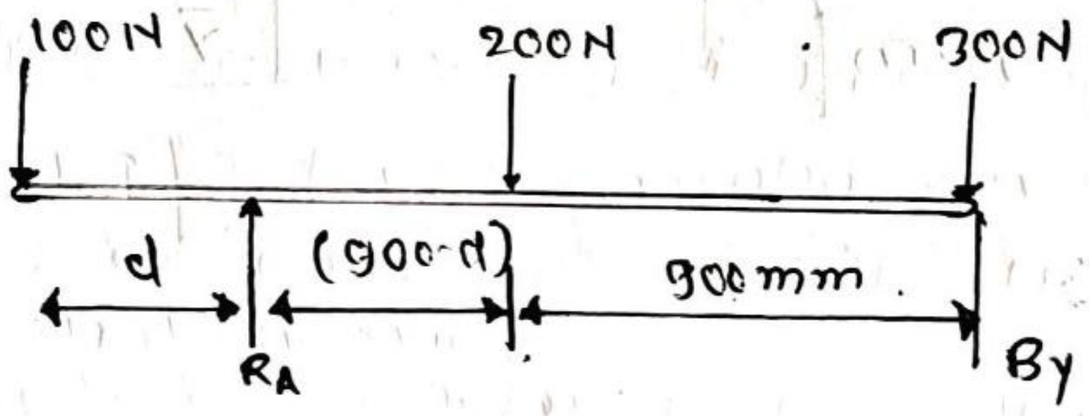
Question no : 01

The maximum allowable value of each of the reactions is 360 N neglecting the weight of the beam determine range of values of distance 'd' for which the beam is safe . Refer . fig .



Solution :-

F . B . D of beam :



The maximum allowable value of each reaction is 360 N .

Case - I

when $R_A = 360 \uparrow$

$\Sigma M_B = 0$

$(200 \times 900) + (100 \times 1800) - 360(1800-d) = 0$

$\therefore d = 800$ mm .

Case - II .

when $B_y = 360$ N $\uparrow$

$\Sigma M_A = 0$

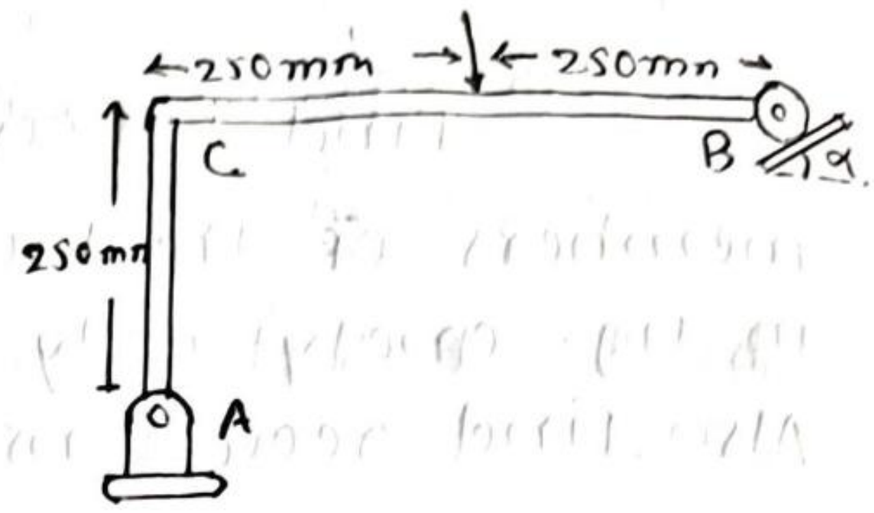
$360 \times (1800-d) + (100 \times d) - 200(900-d) - 300 (1800-d) = 0$.

$\therefore d = 300$ mm .

Range $\rightarrow$ 300mm $\leq d \leq$ 800mm .

Question no % 02

Determine the reaction at A and B for the member ACB loaded and supported as shown in fig. when $\alpha = 30^\circ$



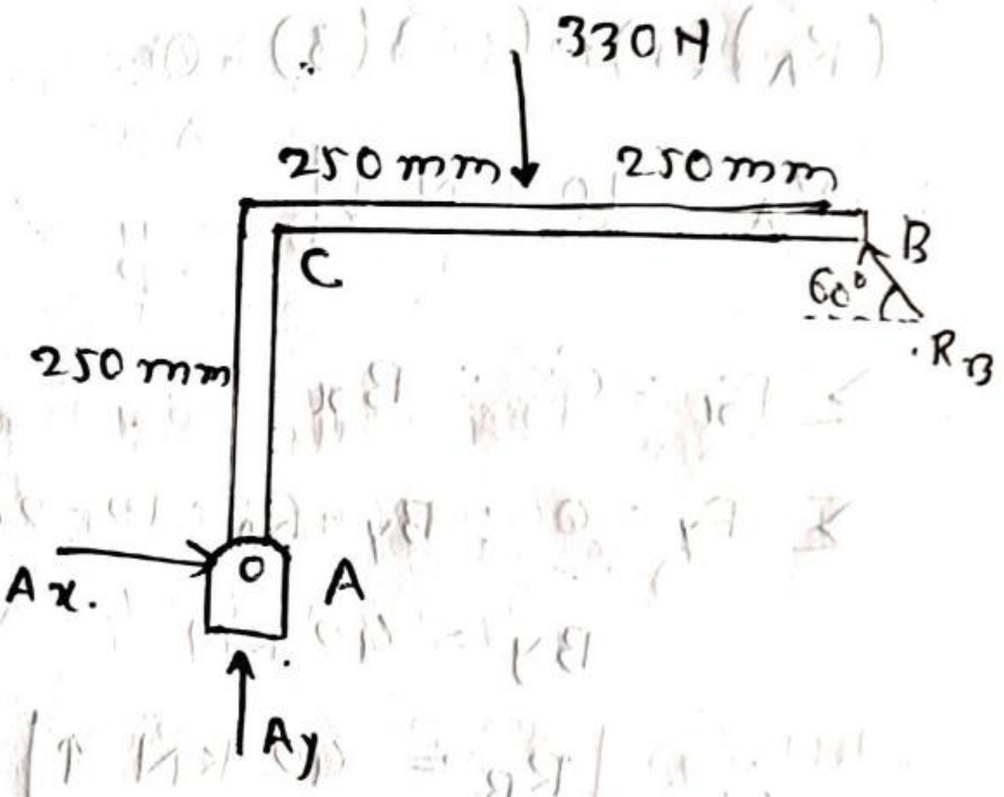
Solution:

The F.B.D of member ACB is shown in fig.

$\sum M_A = 0$

$(R_B \cos 60)(250) + (R_B \sin 60)(500) - (330)(250) = 0$

$\therefore \boxed{R_B = 147.85\ N}$



$\sum F_x = 0$:

$A_x - R_B \cos 60 = 0$

$A_x = 73.925\ N$

$\sum F_y = 0$:

$A_y - 330 + R_B \sin 60 = 0$

$A_y = 201.96\ N$

$R_A = \sqrt{A_x^2 + A_y^2}$

$= \sqrt{73.925^2 + 201.96^2}$

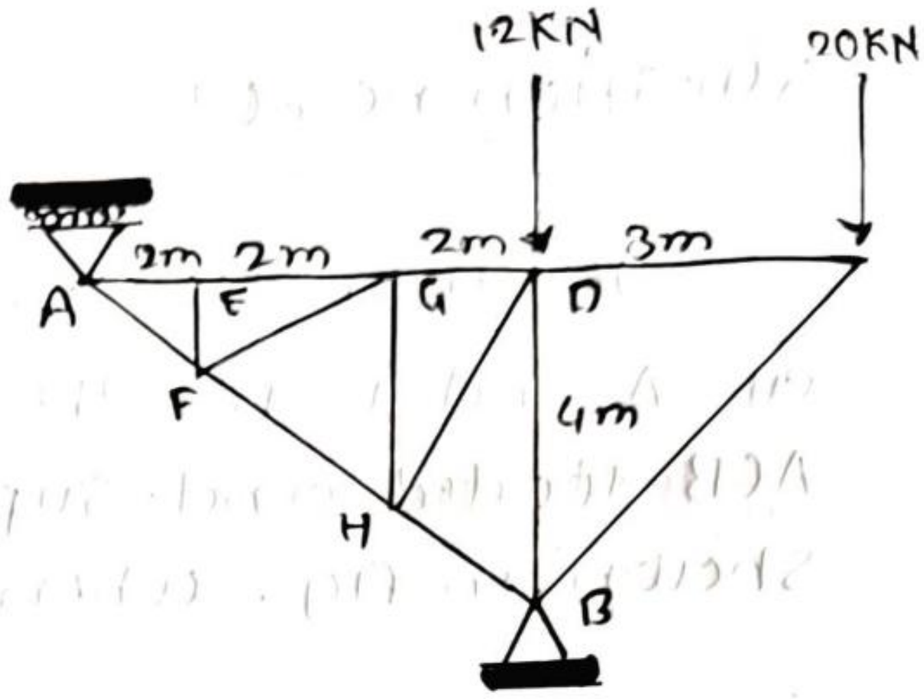
$\therefore \boxed{R_A = 215.06\ N}$

$\theta_A = \tan^{-1}\left(\frac{|R_y|}{|R_x|}\right) = \tan^{-1}\left(\frac{201.96}{73.925}\right)$

$\therefore \boxed{\theta_A = 69.9^\circ \nearrow}$

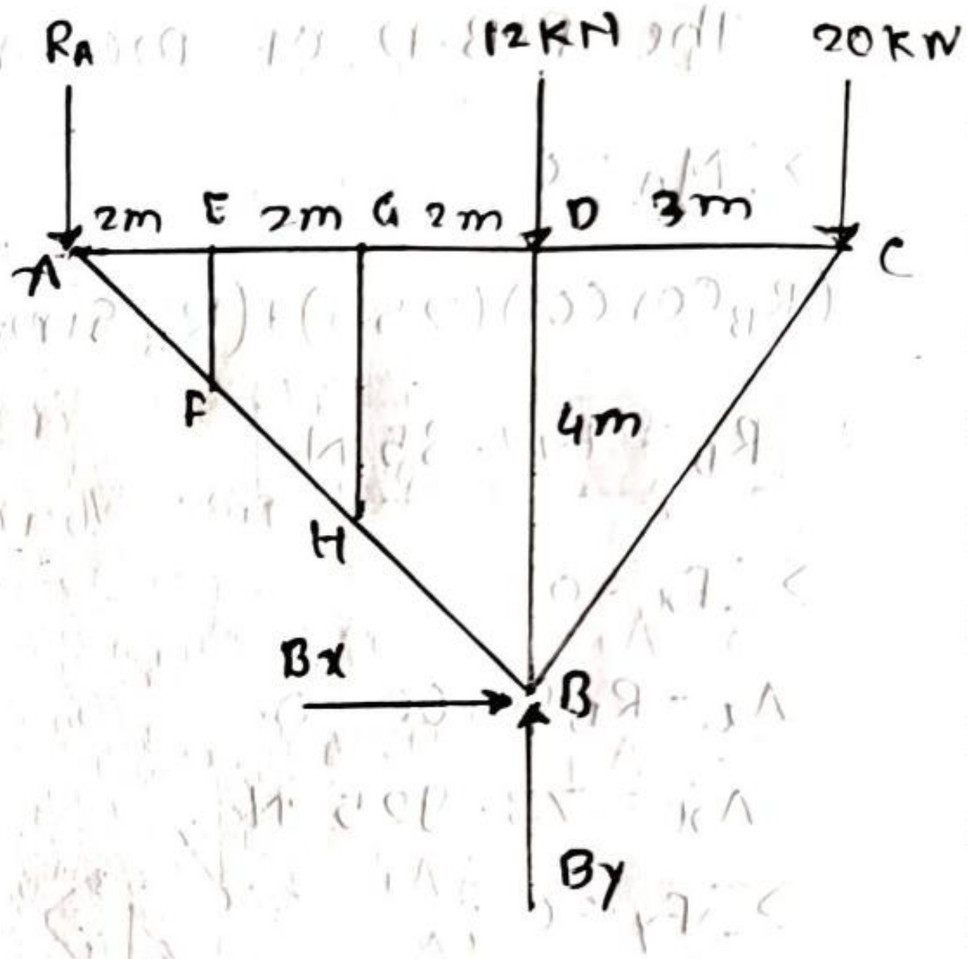
Question No: 03

Find forces in all members of the truss shown in fig. analytically or graphically Also find reactions at supports.



Solution:

From F.B.D. of truss shown in fig.



$\sum M_B = 0$

$(R_A)(6) - (20)(3) = 0$

$\therefore \boxed{R_A = 10\ KN \downarrow}$

$\sum F_x = 0 \quad \therefore B_x = 0$

$\sum F_y = 0 : B_y - R_A - 12 - 20 = 0$

$B_y = 42\ KN$

$\therefore \boxed{R_B = 42\ KN \uparrow}$

At joint E, AE and EG are collinear.

$\therefore F_{EP} = 0$

From joint F, $\boxed{F_{FG} = 0}$

From joint G, $\boxed{F_{GH} = 0}$

From joint H, $\boxed{F_{HD} = 0}$

Also, $F_{AE} = F_{EG} = F_{GD} = F_{DC}$ and.

$F_{AF} = F_{FH} = F_{HB}$

From F.B.D of joint A

$\Sigma F_y = 0 \therefore -F_{AF} \sin 33.69 - 10 = 0$

$F_{AF} = -18.028$ kN

$\therefore$ **$F_{AF} = 18.028$ kN (C)**

$\Sigma F_x = 0 : F_{AE} + F_{AF} \cos 33.69 = 0$.

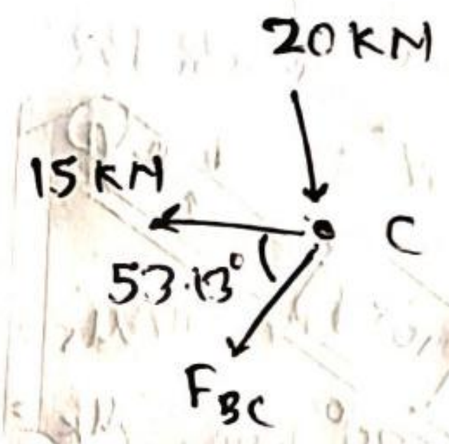
$\therefore$ **$F_{AE} = 15$ KN (T)**

$F_{FH} =$ **$F_{HB} = 18.028$ KN (C)**

$F_{EG} =$ **$F_{GD} = F_{DC} = 15$ KN (T)**

From joint D, **$F_{BD} = 12$ kN (C)**

From F.B.D of joint C.



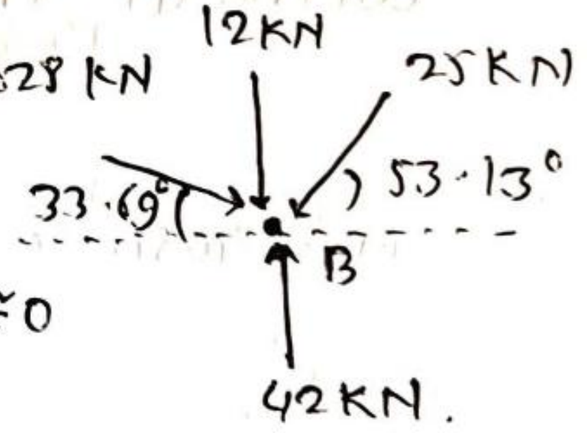
$\Sigma F_y = 0$.

$-F_{BC} \sin 53.13 - 20 = 0$.

$F_{BC} = -25$ KN

$\therefore F_{BC} = 25$ KN (C)

Final check can be obtained from F.B.D of joint B.



$\Sigma F_x = 18.028 \cos 33.69 - 25 \cos 53.13 \simeq 0$

$\Sigma F_y = 42 - 18.028 \sin 33.69 - 12 - 25 \sin 53.13 \simeq 0$

Assignment NO : 03

Name : Pratik . V . Tabhane Roll . no : 116076

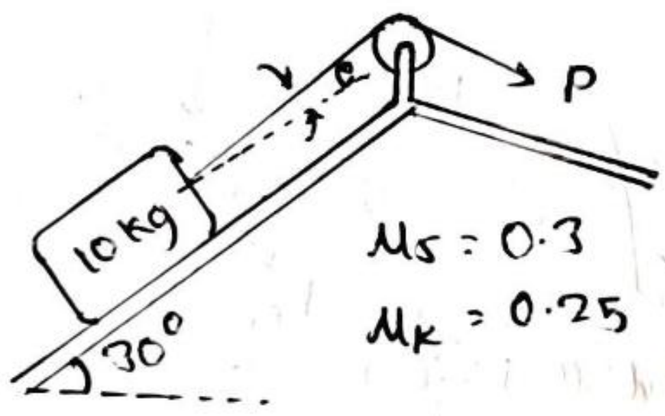
PRN : 1032221030 Div : 16

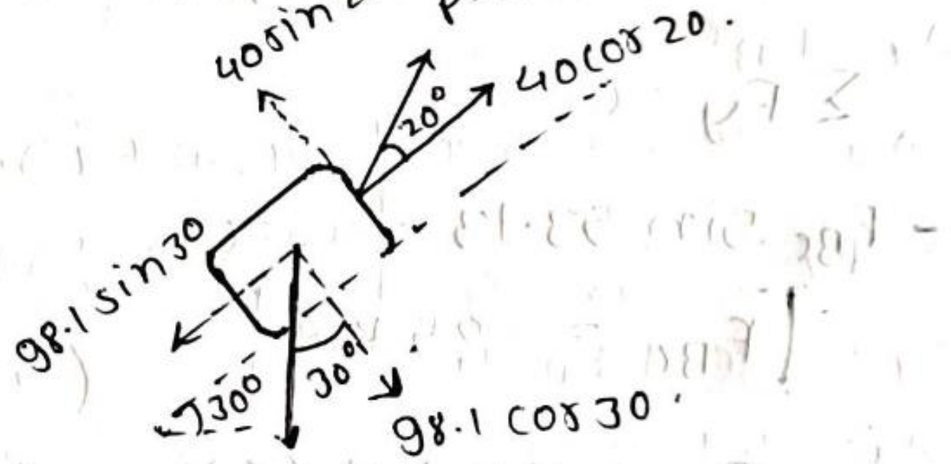
Subject : Engineering Mechanics .

* Solve the following questions :

·Question no : 01 .

Determine whethere the 10 kg block shown in fig is in equilibrium ; and find the magnitude and direction of the friction force when ·P = 40 N and ·θ = 20°





Solution :

The F·B·D of the block is shown in fig .

without the frictional force,

$$\sum F_y = 0$$

$$N_1 + 40 \sin 20 - 98.1 \cdot \cos 30 = 0$$

$$N_1 = 71.276 \text{ N} .$$

$$(F_f)_{max} = \mu_s N_1 = 0.3 \times 71.276 .$$

$$(F_f)_{max} = 21.383 \text{ N} .$$

$$\cdot \Sigma F_x = \cdot 40 \cos 20 - 98.1 \sin 30 = -11.46 \text{ N} .$$

$$\Sigma f_x = 11.46 \text{ N directed down the incline.}$$

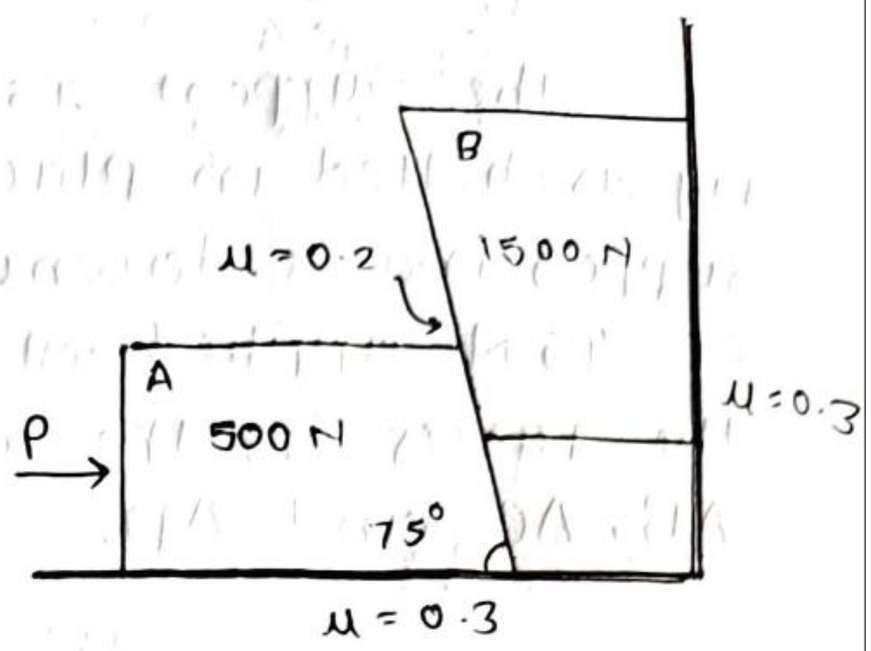
$$\Sigma f_x < (F_f)_{max} .$$

The block is in equilibrium .

$$F_f = 11.46 \text{ N}, 30^\circ$$

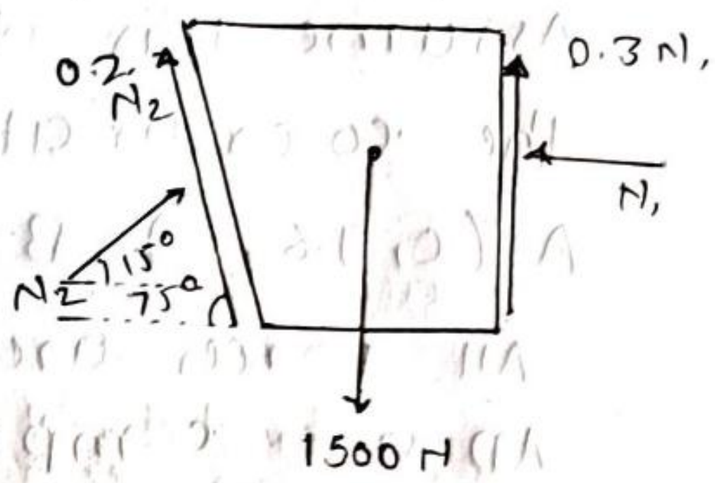
Question no : 02

Find the minimum horizontal force 'P' to be applied to block 'A' weight 500 N so as to keep block 'B' of 1500 N in limiting condition of equilibrium. Refer. Fig.



Solution:

For minimum force P, block B has tendency to move downward and A has tendency to move towards left. The F.B.D of blocks A and B are shown in fig.



For B, $\sum F_x = 0$

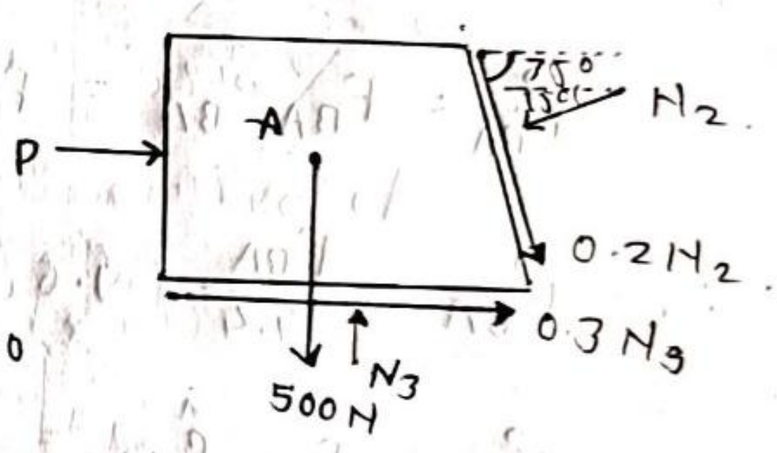
$-N_1 + N_2 \cos 15 - 0.2 N_2 \cos 75 = 0$

$\sum F_y = 0$

$0.3 N_1 + N_2 \sin 15 + 0.2 N_2 \sin 75 - 1500 = 0$

$N_1 = 1888.1 N,$

$N_2 = 2065.4 N,$



For A, $\sum F_y = 0$.

$N_3 - 500 - 0.2 N_2 \sin 75 + N_2 \sin 15 = 0$

$\therefore \quad N_3 = 1433.57 N.$

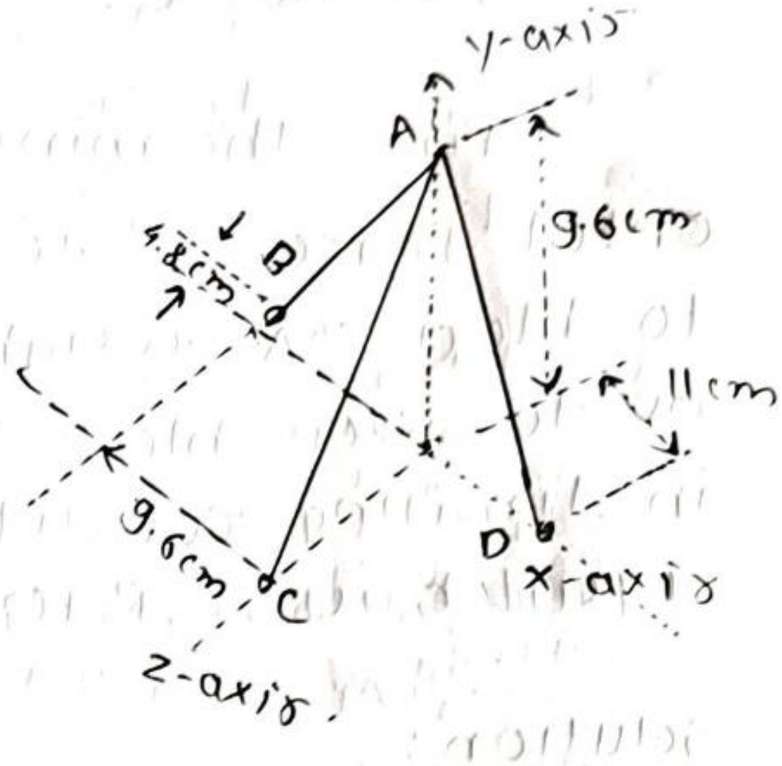
$\sum F_x = 0.$

$P - N_2 \cos 15 + 0.2 N_2 \cos 75 + 0.3 N_3 = 0$

$P = 1458.04 N.$

Question no: 03.

The support assembly shown in Fig. is bolted in place 'B', 'C' and 'D' supporting a downward force of 45 N applied at 'A'. Determine the forces in the members AB, AC and AD.



Solution:

Distance of C from origin is not given.

Assume this distance to be 11cm.

The co-ordinates of points are:

A (0, 9.6, 0), B (-9.6, 0, -4.8), C (0, 0, 11), D (11, 0, 0)

All forces are concurrent at A. Forces in AB, AC and AD are compressive and hence are directed toward A.

$$\vec{W} = -45\,\hat{j}$$

$$\vec{F}_{BA} = F_{BA}\,\hat{e}_{BA} = F_{BA}\left[\frac{9.6\,\hat{i} + 9.6\,\hat{j} + 4.8\,\hat{k}}{\sqrt{9.6^2 + 9.6^2 + 4.8^2}}\right]$$

$$\therefore \quad \vec{F}_{BA} = \frac{F_{BA}}{14.4}\left(9.6\,\hat{i} + 9.6\,\hat{j} + 4.8\,\hat{k}\right)$$

$$\vec{F}_{CA} = F_{CA}\cdot\hat{e}_{CA} = F_{CA}\left[\frac{0\hat{i} + 9.6\hat{j} - 11\hat{k}}{\sqrt{9.6^2 + 11^2}}\right]$$

$$\therefore \quad \vec{F}_{CA} = \frac{F_{CA}}{14.6}\left(0\hat{i} + 9.6\,\hat{j} - 11\,\hat{k}\right)$$

$$\vec{F}_{DA} = F_{DA}\,\hat{e}_{DA} = F_{DA}\left[\frac{-11\,\hat{i} + 9.6\hat{j} + 0\hat{k}}{\sqrt{11^2 + 9.6^2}}\right]$$

$$\therefore \quad \vec{F}_{DA} = \frac{F_{DA}}{14.6}\left(-11\,\hat{i} + 9.6\,\hat{j} + 0\hat{k}\right)$$

$$\therefore \quad \Sigma F_x = 0: \quad \frac{9.6\,F_{DA}}{14.4} - \frac{11\,F_{DA}}{14.6} = 0.$$

$$\Sigma F_y = 0 \quad -45 + \frac{9.6\,F_{BA}}{14.4} + \frac{9.6\,F_{CA}}{14.6} + \frac{9.6\,F_{DA}}{14.6} = 0.$$

$$\Sigma F_z = 0 \quad \frac{4.8\,F_{BA}}{14.4} - \frac{11\,F_{CA}}{14.6} = 0$$

$F_{DA} = 29.23$ N

$F_{CA} = 12.93$ N

$F_{DA} = 25.87$ N

Assignment NO : 04

Name : Pratik . v. Tabhane.

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Div : 16

Subject : Engineering mechanics.

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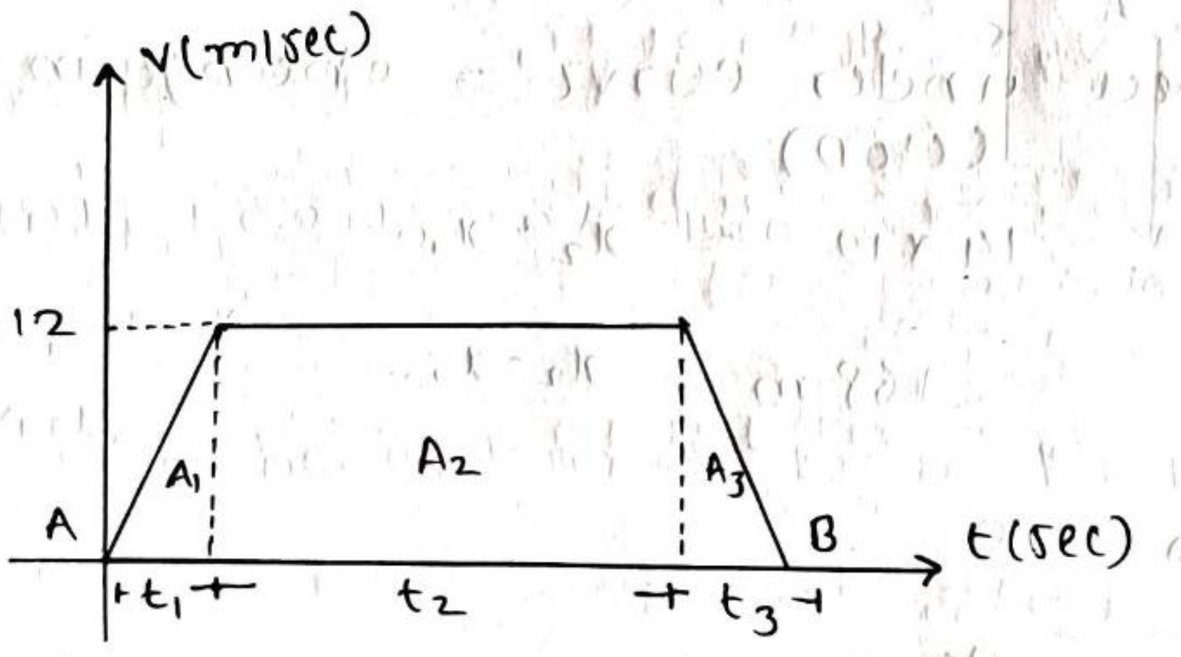
* Solve the following questions.

Question no : 01.

A bus starts from rest point A accelerater at 0.8 m/sec² till it reaches maximum velocity 12 m/sec. After some time, brakes are applied it comes to stop at point B, which is 42 m beyond the point where brakes were applied. Knowing that acceleration is uniform and total time is 36 sec find distance between the points A and B with the help of v-t diagram. Also draw s-t diagram.

Solution :-



(A to C)

Slope of v-t diagram = accl^n

$$\Rightarrow \frac{(v_1 - v_0)}{(t_1) - (t_0)} = 0.8$$

$$\Rightarrow \frac{12 - 0}{t_1 - 0} = 0.8$$

$$\Rightarrow \boxed{t_1 = 15 \text{ sec}}$$

Area under v-t diagram = change in position.
(A to C)

$\frac{1}{2} \times 15 \times 12 = x_1 - x_0$.

$90\ m = x_1$

$x_3 = 42m$.

∴ Area under v-t diagram = change in position.
(D to B)

$\frac{1}{2} \times t_3 \times 12 = x_3 - x_2$.

$\frac{1}{2} \times t_3 \times 12 = 42$.

$t_3 = 7sec$

we know that

$t_1 + t_2 + t_3 = 36sec$.

$15 + t_2 + 7 = 36$.

$t_2 = 14sec$.

∴ Area under curve = change in position.
(C to D)

$14 \times 12 = x_2 - x_1$

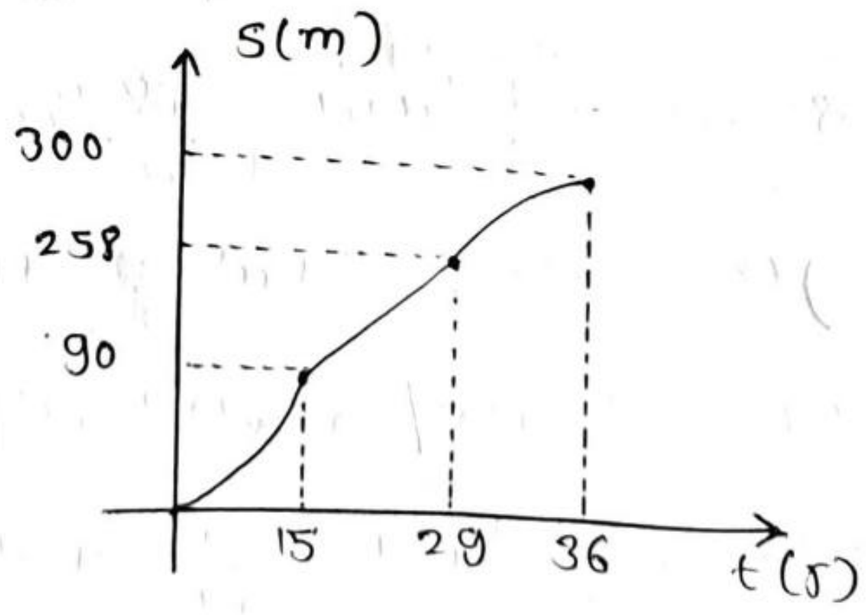
$168\ m = x_2 - x_1$

$x_0 = 0$

$x_{15} = 90\ m$

$x_{29} = 90 + 168 = 258\ m$.

$x_{36} = 90 + 162 + 42 = 300\ m$.



Question no 02.

A car start from rest on a circular curve of a 250 m radius and accelerater at a constant tangential acceleration 1.2 m/sec². Determine distance travelled and time taken when magnitude of total acceleration of car becomes 1.5 m/sec².

Soln:- Given:

$a_t = 1.2\ m/s^2$ (constant)

$a = 1.5\ m/s^2$

$a = \sqrt{a_t^2 + a_n^2} = 1.5 = \sqrt{1.2^2 + a_n^2}$

$a_n = 0.9\ m/s^2$.

But $a_n = \frac{v^2}{\rho}$

$a.g = \frac{v^2}{250}$

$v = 15\ m/s$.

An tangential acceleration is constant, we can use kinematical equations in tangential direction.

$u = 0,\ v = 15\ m/s,\ a = 1.2\ m/s^2$.

$v = u + at \Rightarrow 15 = 0 + 1.2 \times t$.

$t = 12.5\ s$.

$s = ut + \frac{1}{2} at^2 \Rightarrow s = 0 + \frac{1}{2} \times 1.2 \times 12.5^2$.

$s = 93.75\ m$.

Question no: 03.

The y-co-ordinate of a particle moving along a curve is $y = t^3 \Rightarrow 6t + 3$ where y is in metres and t in seconds. Its acceleration in x-direction is given by $a_x = 4t + 3\ m/s^2$. If velocity of the particle in x direction is 2 m/s when t=0, calculate the magnitude and direction of velocity and acceleration of the particle when t=1s.

Solution: $y = t^3 - 6t + 3$

$v_y = \frac{dy}{dt} = 3t^2 - 6$

$a_y = \frac{dv_y}{dt} = 6t$

$a_x = 4t + 3$

$\frac{dv_x}{dt} = 4t + 3$

$v_x = \frac{4t^2}{2} + 3t + c_1$

$\therefore v_x = 2t^2 + 3t + c_1$

At $t = 0$, $v_x = 2\ m/s$.

$\therefore 2 = c_1$

$\therefore v_x = 2t^2 + 3t + 2$

$t = 1s$,

at $v_x = 2 + 3 + 2 = 7\ m/s$.

$v_y = 3 - 6 = -3\ m/s$.

$v = \sqrt{v_x^2 + v_y^2} = \sqrt{7^2 + 3^2} = 7.62\ m/s$.

$\theta_v = \tan^{-1} \frac{v_y}{v_x} = \tan^{-1} \frac{3}{7} = 23.2°$ ↘

$a_x = 4 + 3 = 7\ m/s^2$; $a_y = 6 \times 1 = 6\ m/s^2$.

$a = \sqrt{a_x^2 + a_y^2} = \sqrt{7^2 + 6^2} = 9.22\ m/s^2$.

$\theta_a = \tan^{-1} \frac{a_y}{a_x} = \tan^{-1} \frac{6}{7} = 40.6°$ ↗

Assignment No : 05

Name : Pratik . V. Tabhane Roll No : 116076.

PRN : 1032221030 Div : 16

Subject : Engineering Mecanics.

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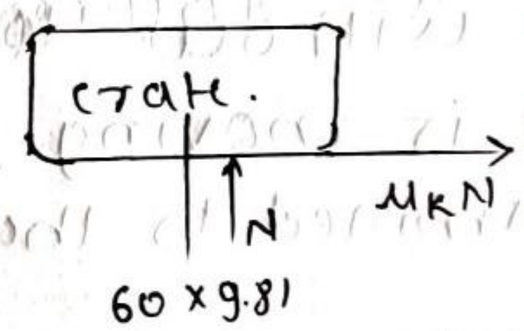
* Solve the following questions:

Question no : 01.

A crate having a mass of 60 kg fall horizontally off the back of a truck which is traveling at 90 km/h Determine the coefficient of kinetic friction between the road and the crate if the crate slides 45m on the ground with no tumbling along the road before coming to rest. Assume that initial velocity of crate along the road is 80 km/h Refer fig.

Soln:-

$ma = 60 \times 5.487.$



∴ The crate has its initial velocity.
Same as the velocity of truck.

$u = 80 \times \frac{5}{18}$ m/s ←, $v = 0$

$s = 45$ m ←

$v^2 = u^2 + 2as$;

$0 = \left(-80 \times \frac{5}{18}\right)^2 + 2(a)(-45)$

$a = +5.487$ m/s^2.

Positive sign indicater that acceleration is directed towards right, i.e opposite to the motion of crate and hence it is deceleration. The F.B.D of crate is shown in fig.

$$\sum F_y = 0 \quad \therefore N - 60 \times 9.81 = 0$$

$$N = 588.6\ N.$$

$$\sum F_x = ma_x \quad \therefore \mu_K N = ma.$$

$$\mu_K (588.6) = 60 \times 5.487.$$

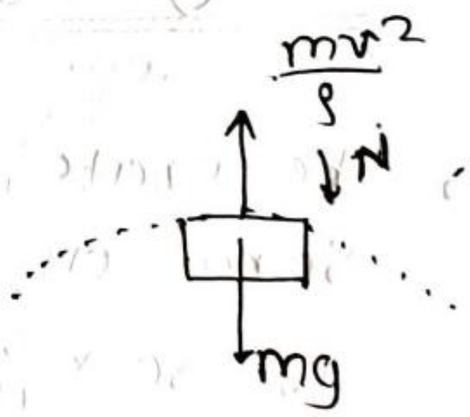
$$\mu_K = 0.559.$$

Question no: 02.

A motor cyclist is moving in a spherical cage of 3.6m radius in a circus show. The mass of motor cycle and the rider together is 240 kg. What shall be the minimum speed with which the motor cyclist can pass through the highest point without losing the contact inside the cage. If he is moving with 36 Kmph, what force is transmitted to the cage?

Solution:

For minimum speed without losing contact with the cage, $N = 0$.



$$\therefore \frac{mv^2}{\rho} - mg = 0.$$

$$v = \sqrt{\rho g}$$

$$\rho = 3.6\ m$$

$$g = 9.81\ m/s^2.$$

$$\therefore v = \sqrt{3.6 \times 9.81}$$

$$\therefore v = 5.943\ m/s.$$

For any speed greated than 5.943 m/s. there will be a non-zero normal reaction. for.

$v = 36\ Km/h = 10\ m/s.$

$v > 5.943\ m/s.$

$\therefore \frac{mv^2}{\rho} - mg - N = 0.$

$$N = \frac{mv^2}{\rho} - mg$$

$$N = \frac{240 \times 10^2}{3.6} - 240 \times 9.81$$

$$N = 4312.27\ N.$$

Question no: 03.

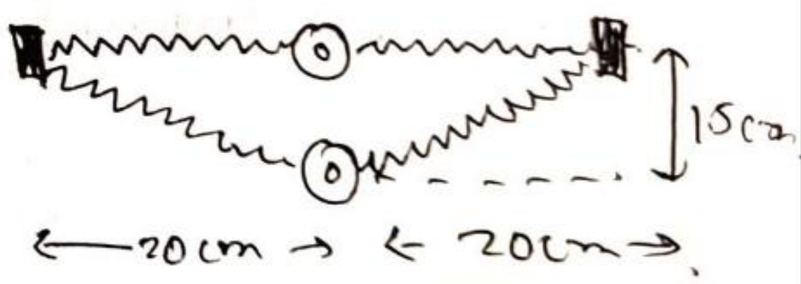
Two springs of stiffness 0.5 N/cm and unstretced length 20 cm each are connected to sphere B of 5kg mass shown in fig: If relesed from rest from this position, Find its velocity when it has fallen through 15 cm.

Solution:

The deformation of each spring in finial position is,

$x = \sqrt{20^2 + 15^2} - 20 = 5cm$

$x = 0.05\ m.$



By conservation of energy

$K.E_1 + G.P.E_1 + S.P.E_1 = K.E_2 + G.P.E_2 + S.P.E_2$

$0 + 5 \times 9.81 \times 0.15 + 0 = \frac{1}{2} \times 5v^2 + 0 + 2\left[\frac{1}{2} \times 50 \times 0.05^2\right]$

$v = 1.7\ m/s.$